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(57) **ABSTRACT**

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(52) **U.S. Cl.** **257/666; 257/672**

(58) **Field of Classification Search** 257/666,
257/676, 672

See application file for complete search history.

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9 Claims, 10 Drawing Sheets

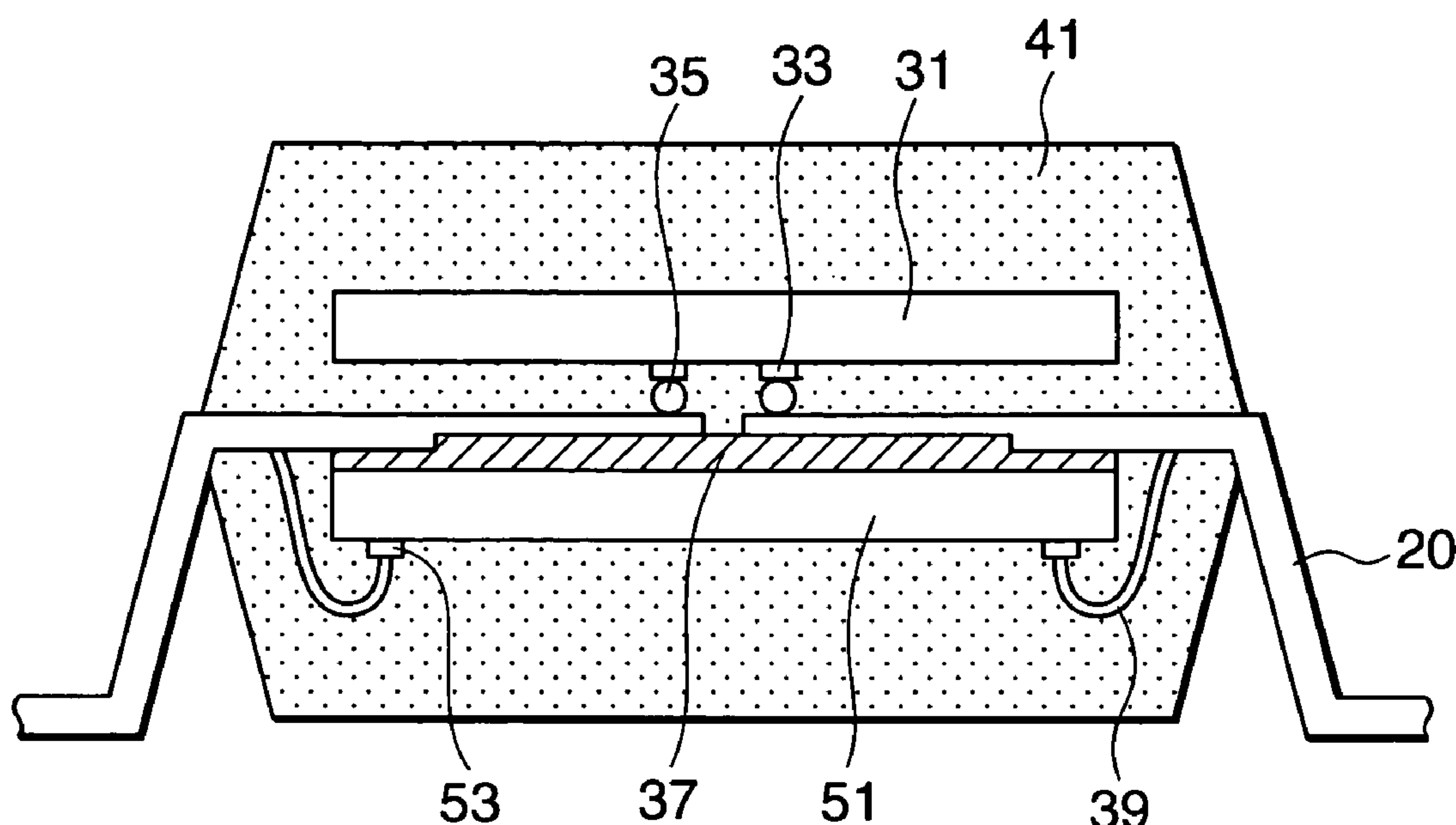


FIG.1A

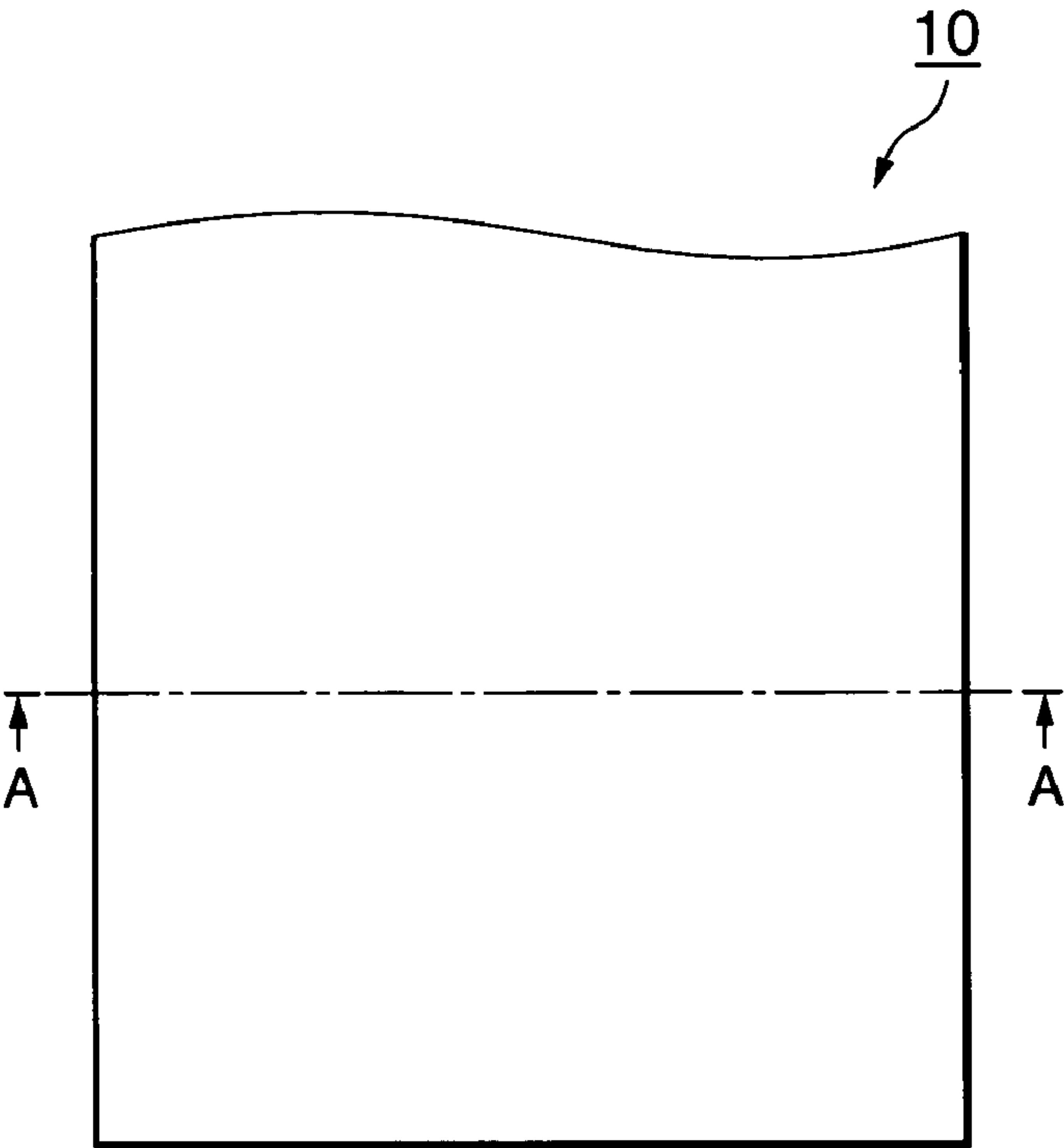
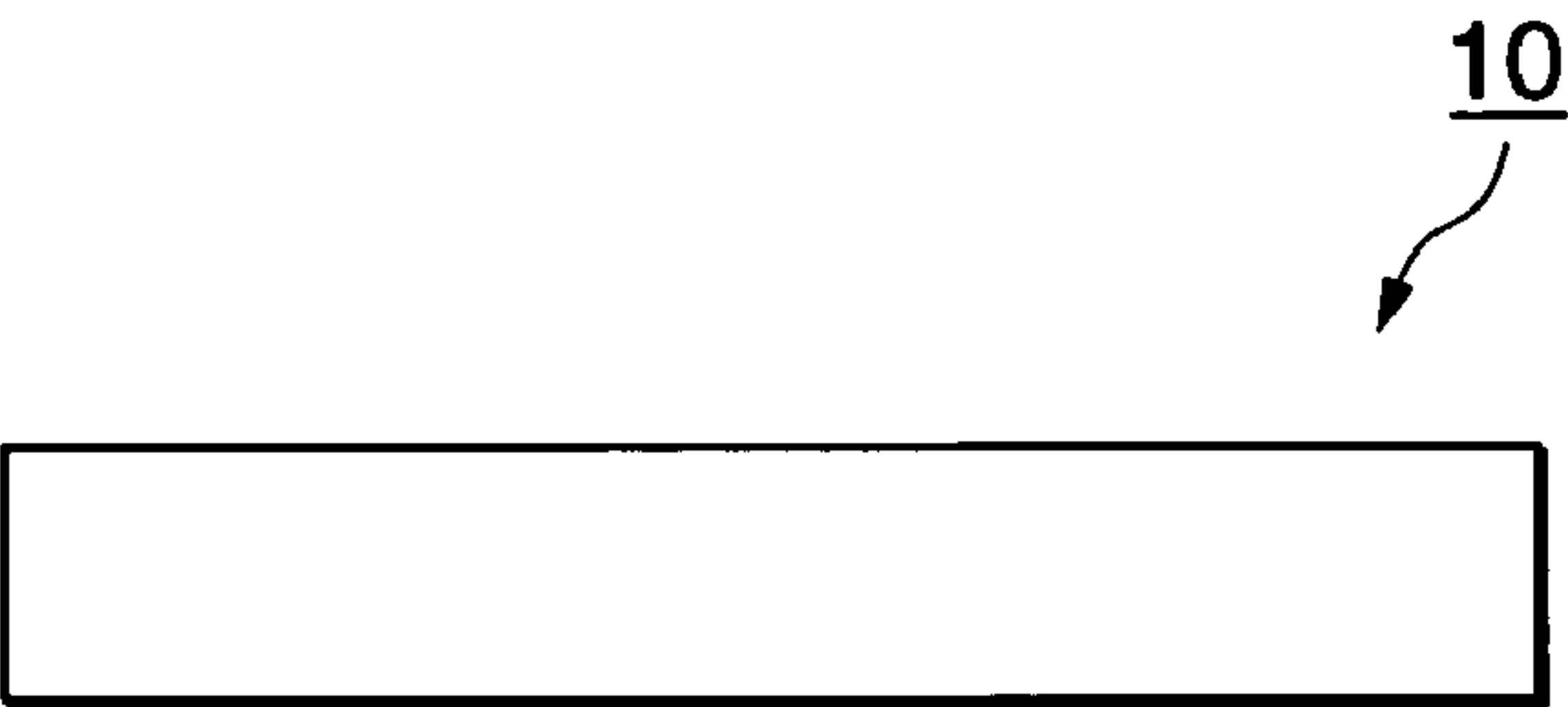


FIG.1B



MANUFACTURING PROCESS OF LEAD FRAME (FIRST STEP)

FIG.2A

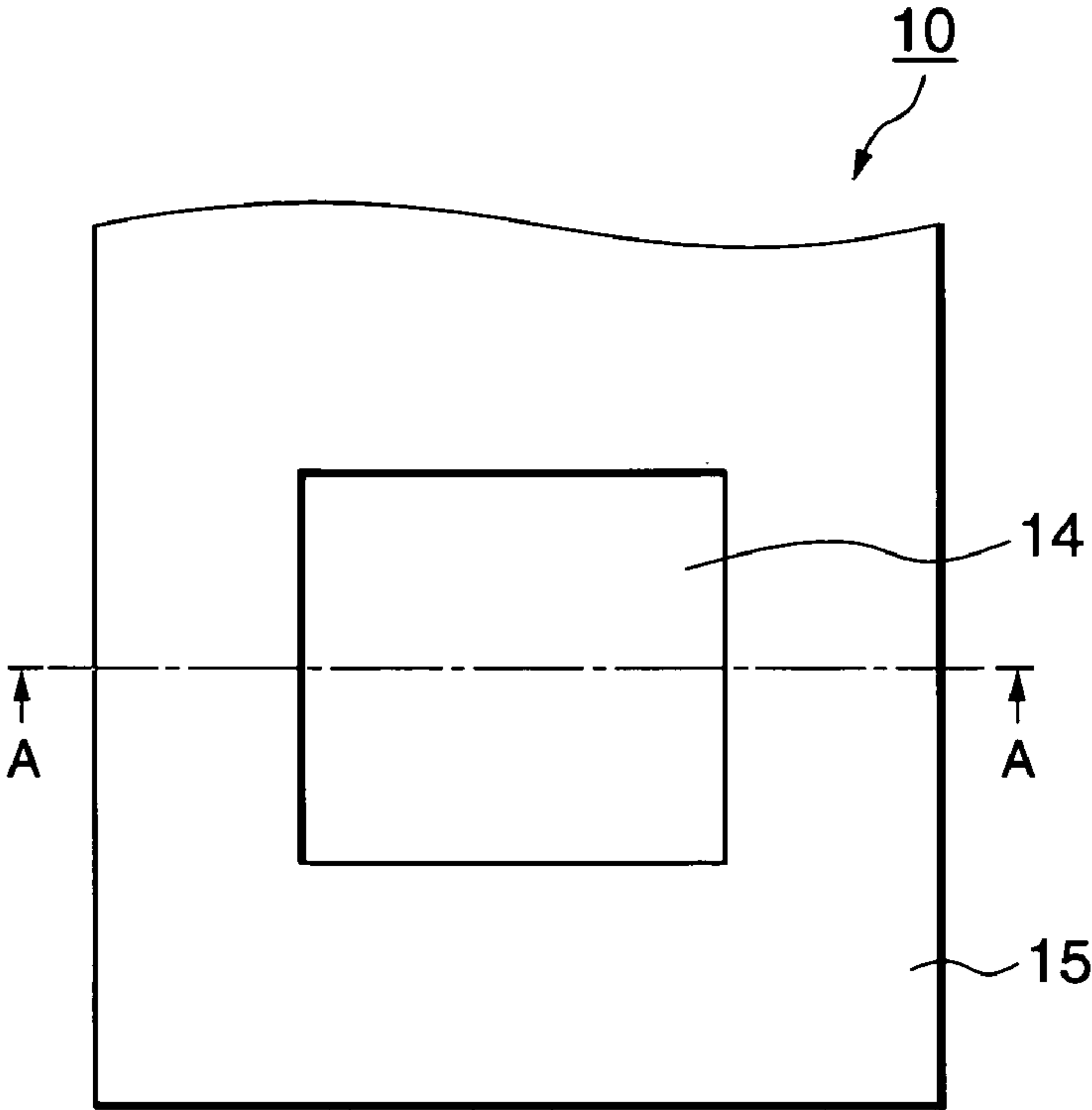
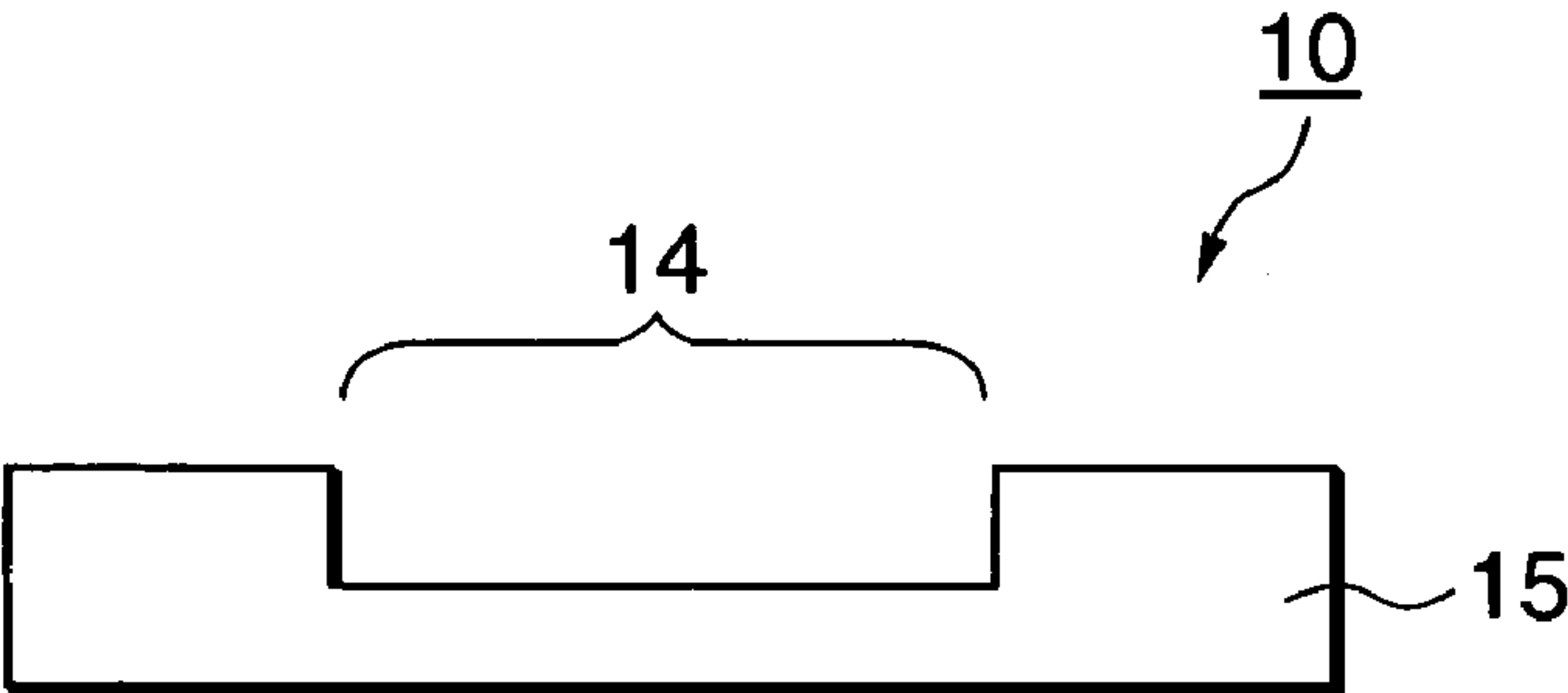


FIG.2B



MANUFACTURING PROCESS OF LEAD FRAME (SECOND STEP)

FIG.3A

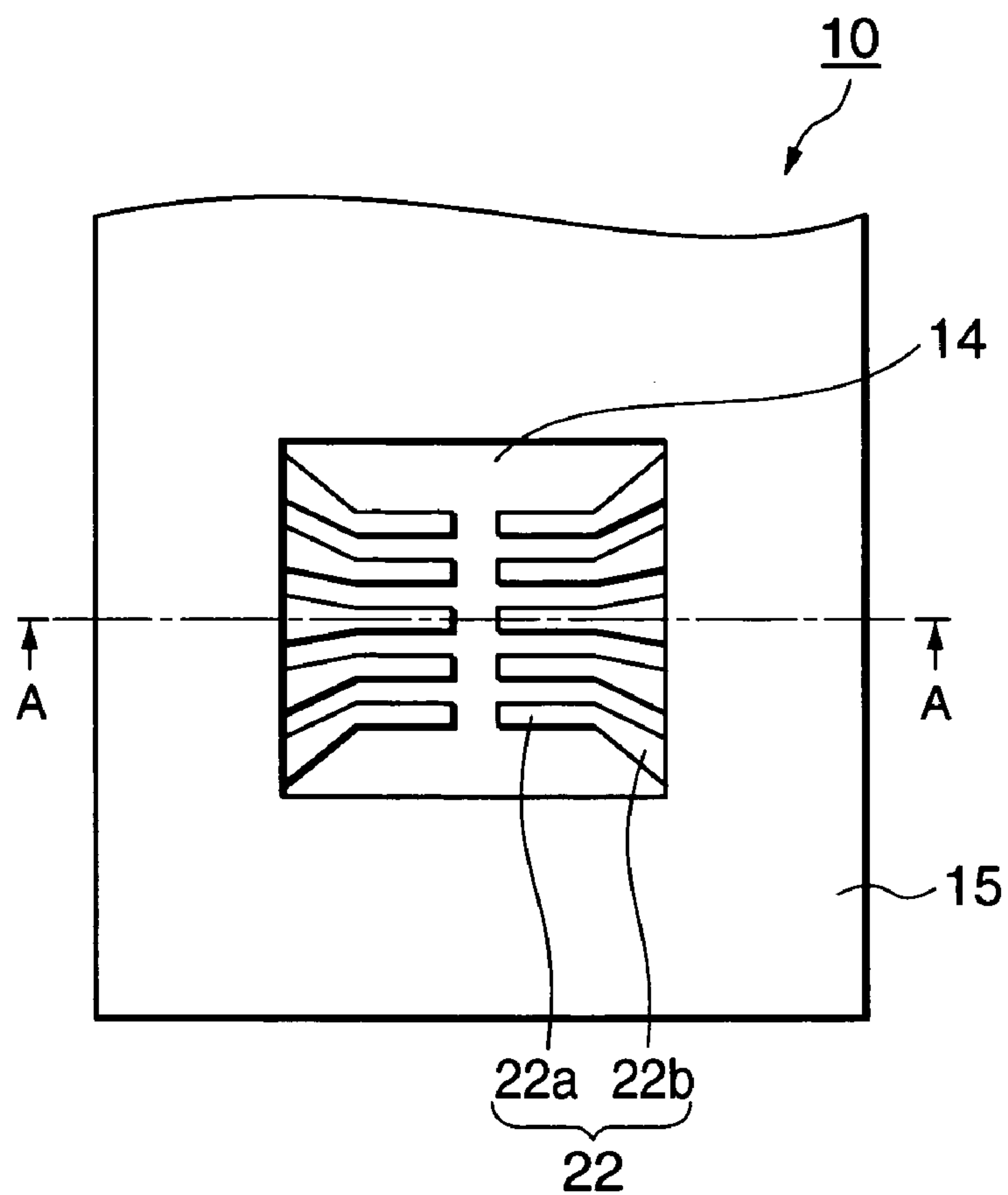
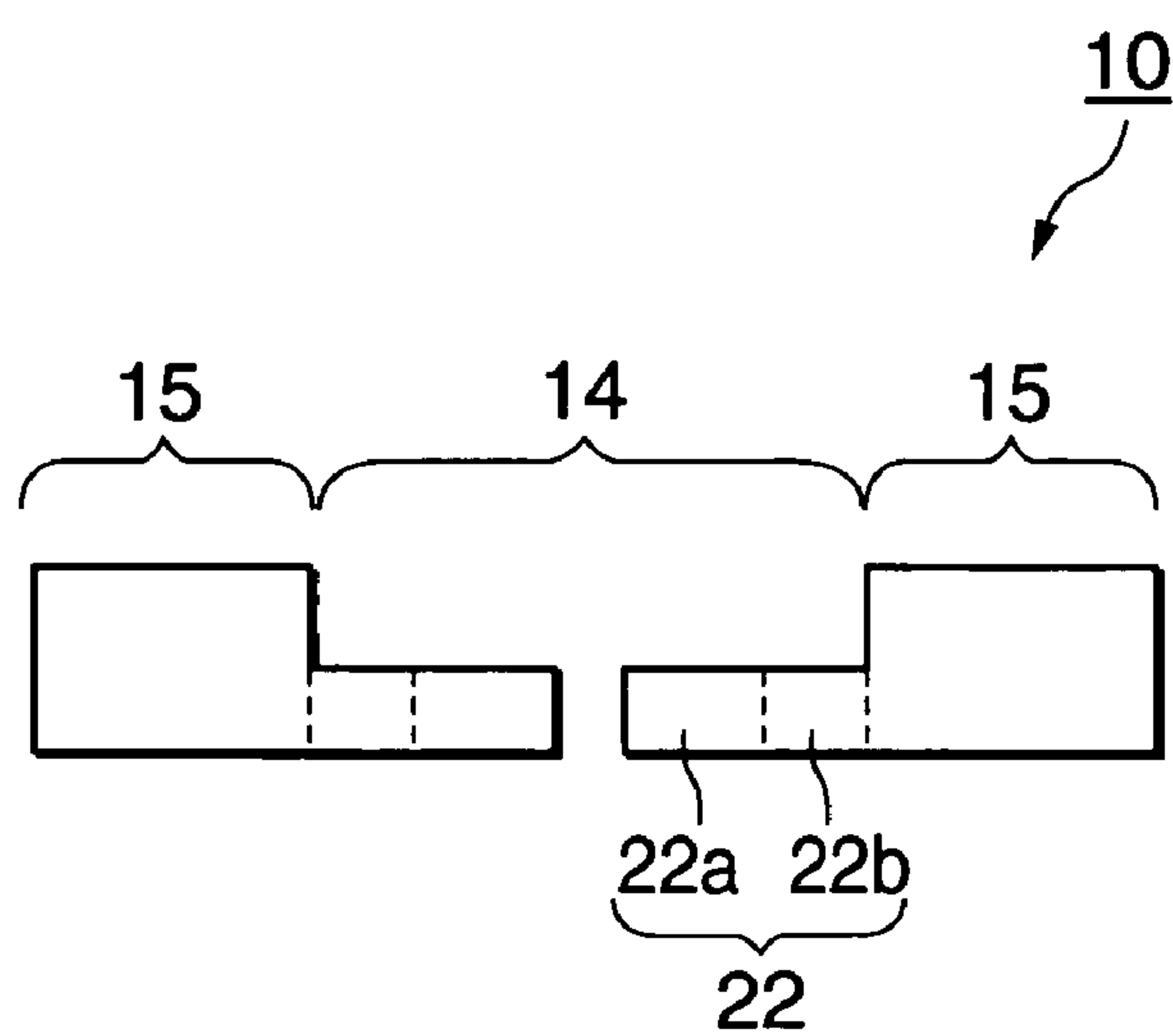


FIG.3B



MANUFACTURING PROCESS OF LEAD FRAME (THIRD STEP)

FIG.4A

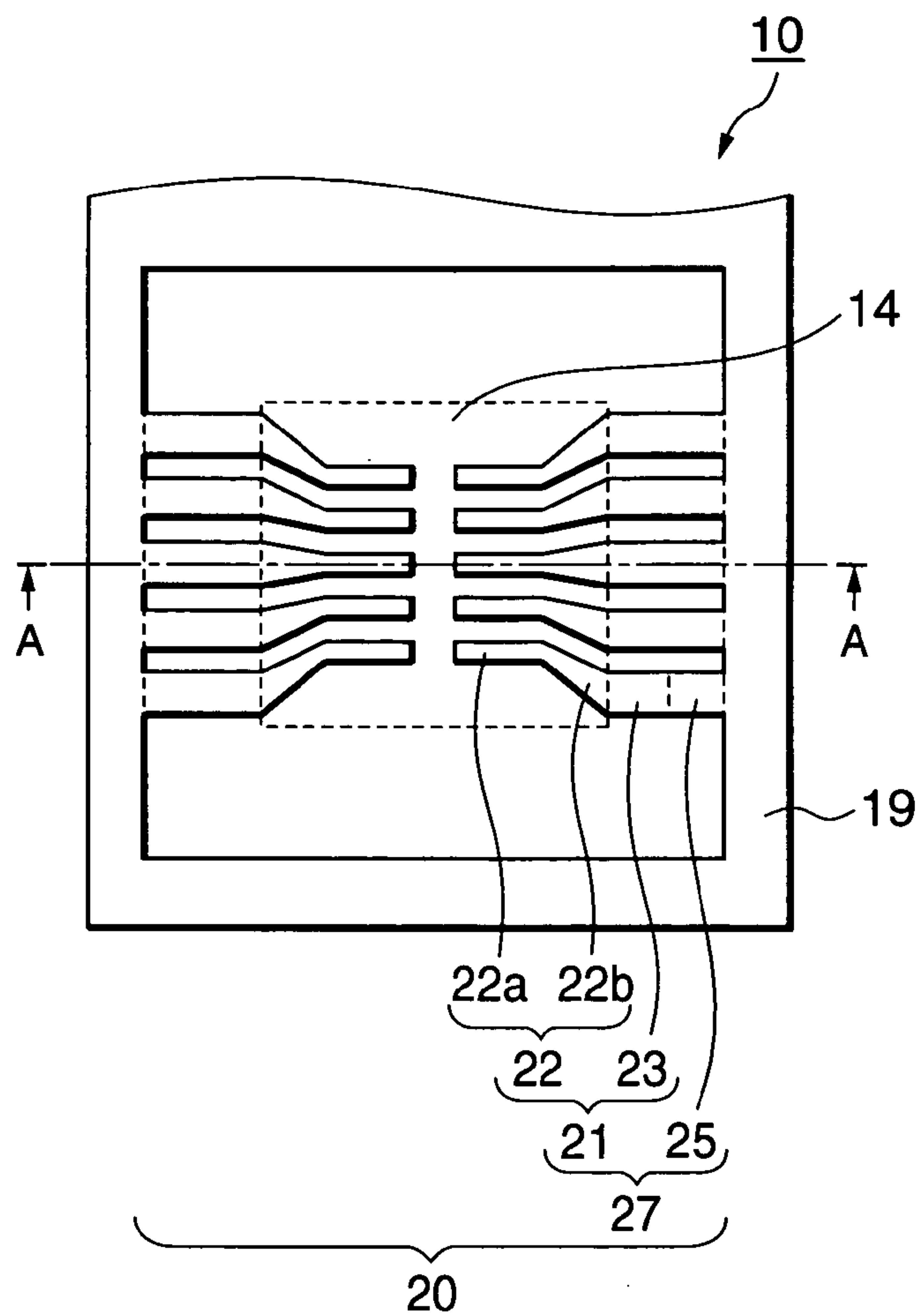
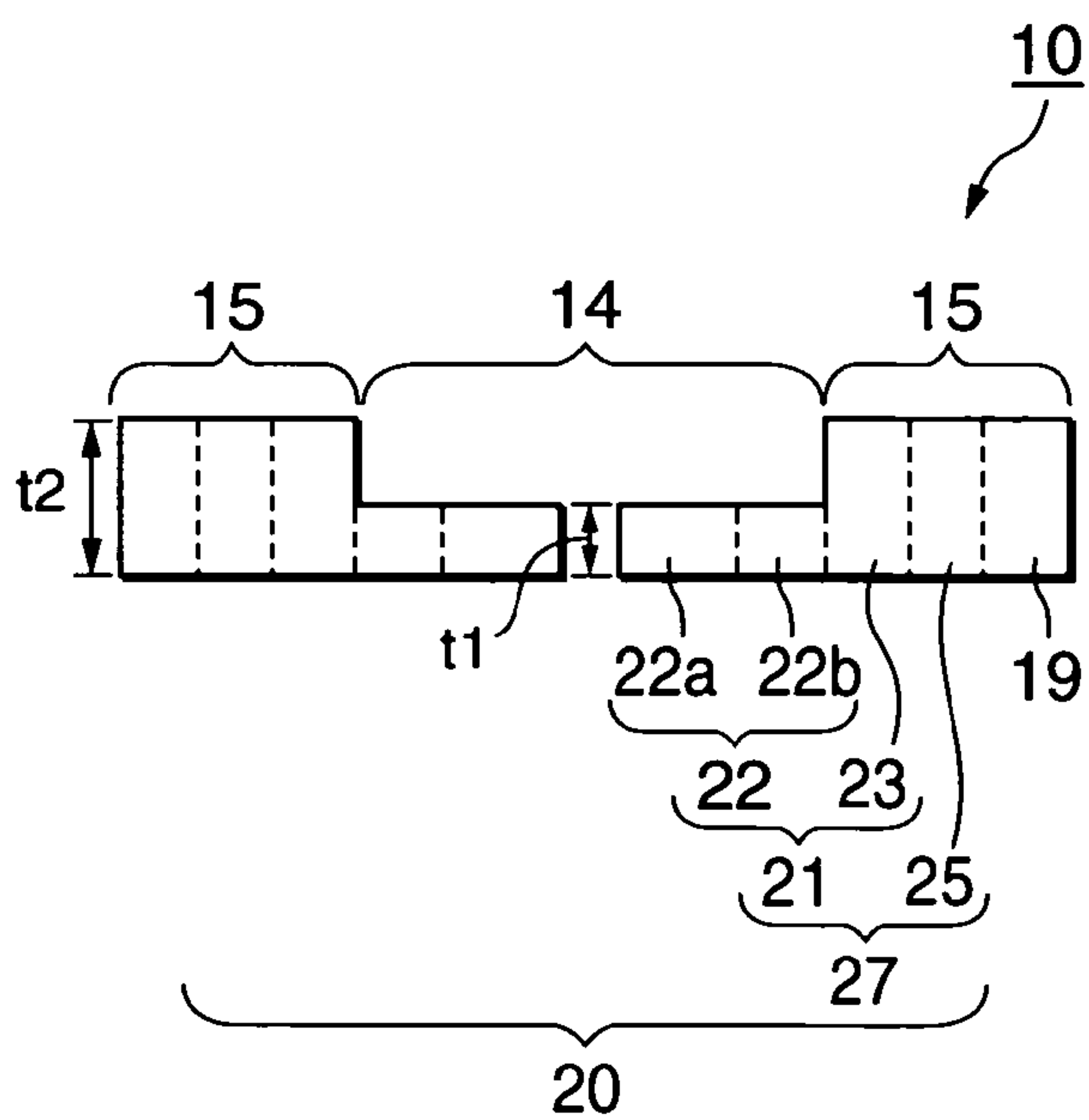


FIG.4B



MANUFACTURING PROCESS OF LEAD FRAME (FOURTH STEP)

FIG.5A

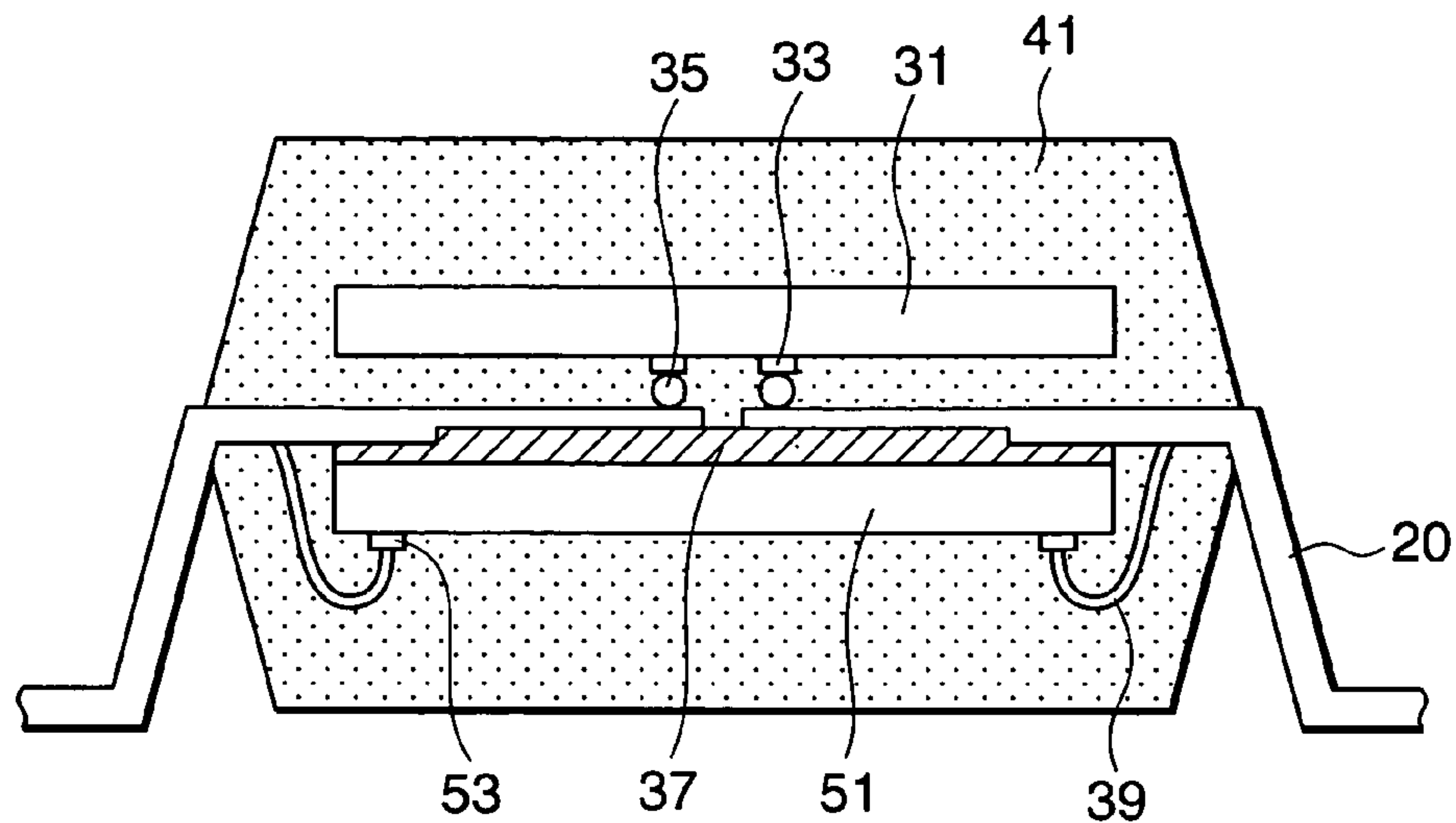
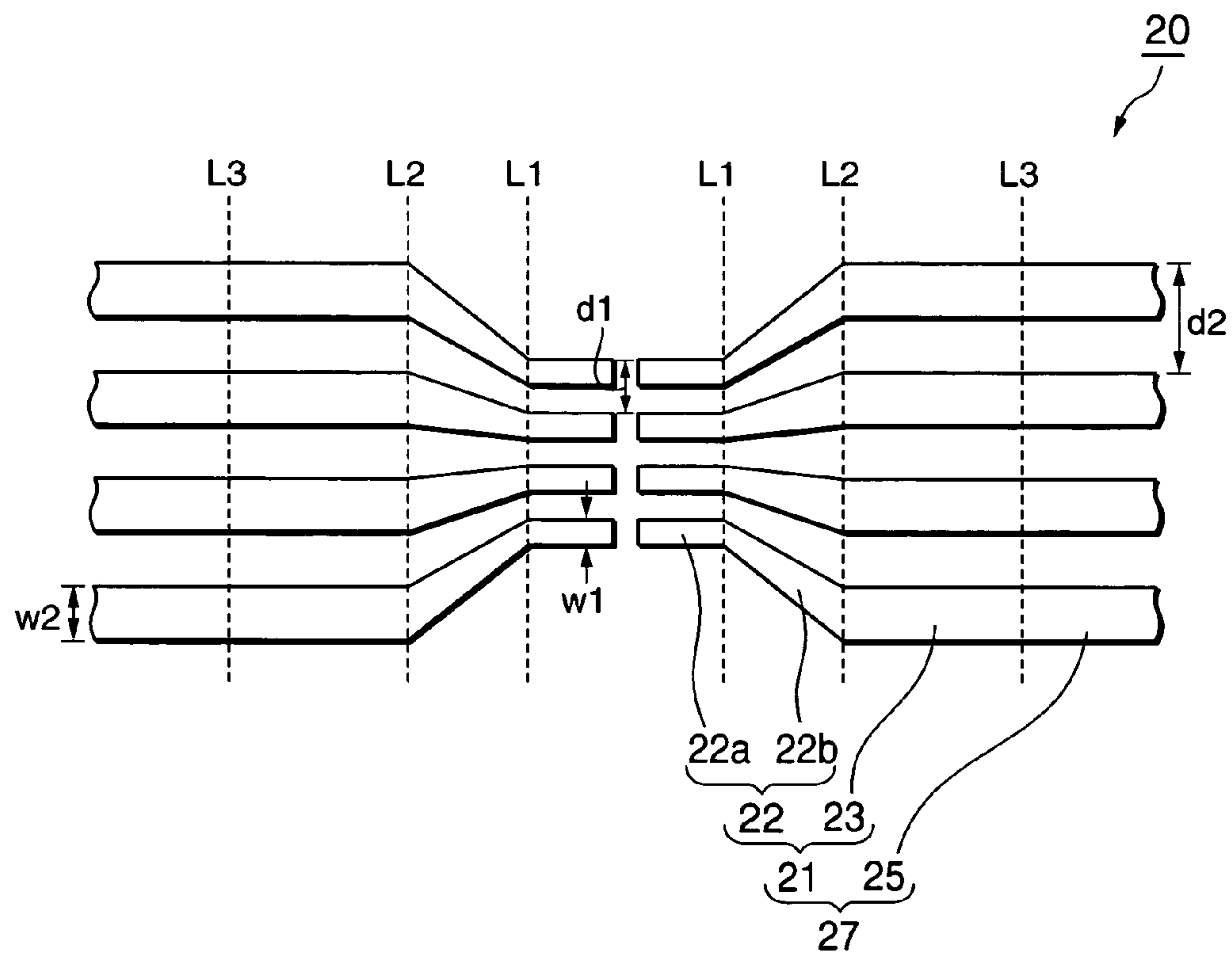
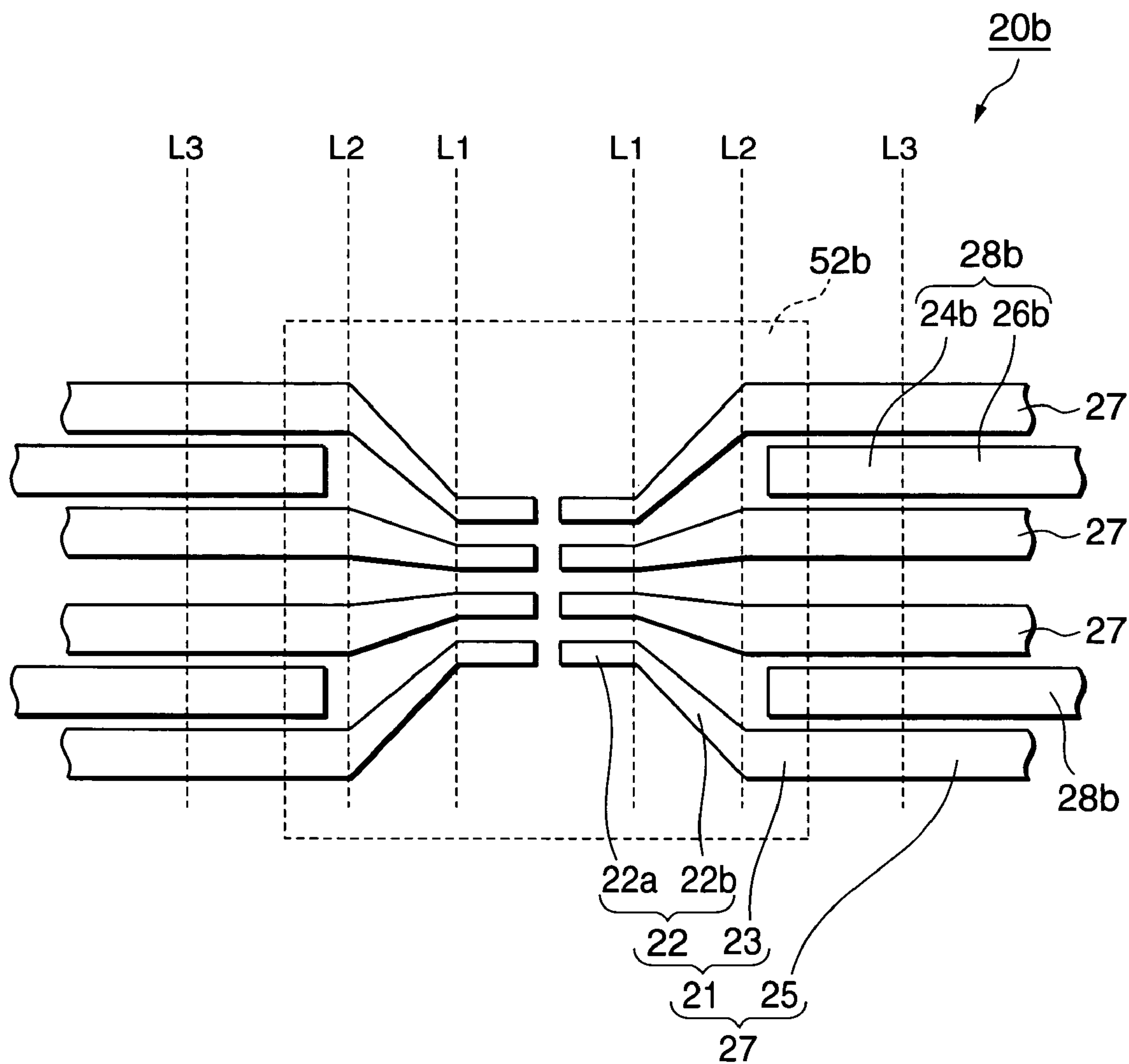


FIG.5B



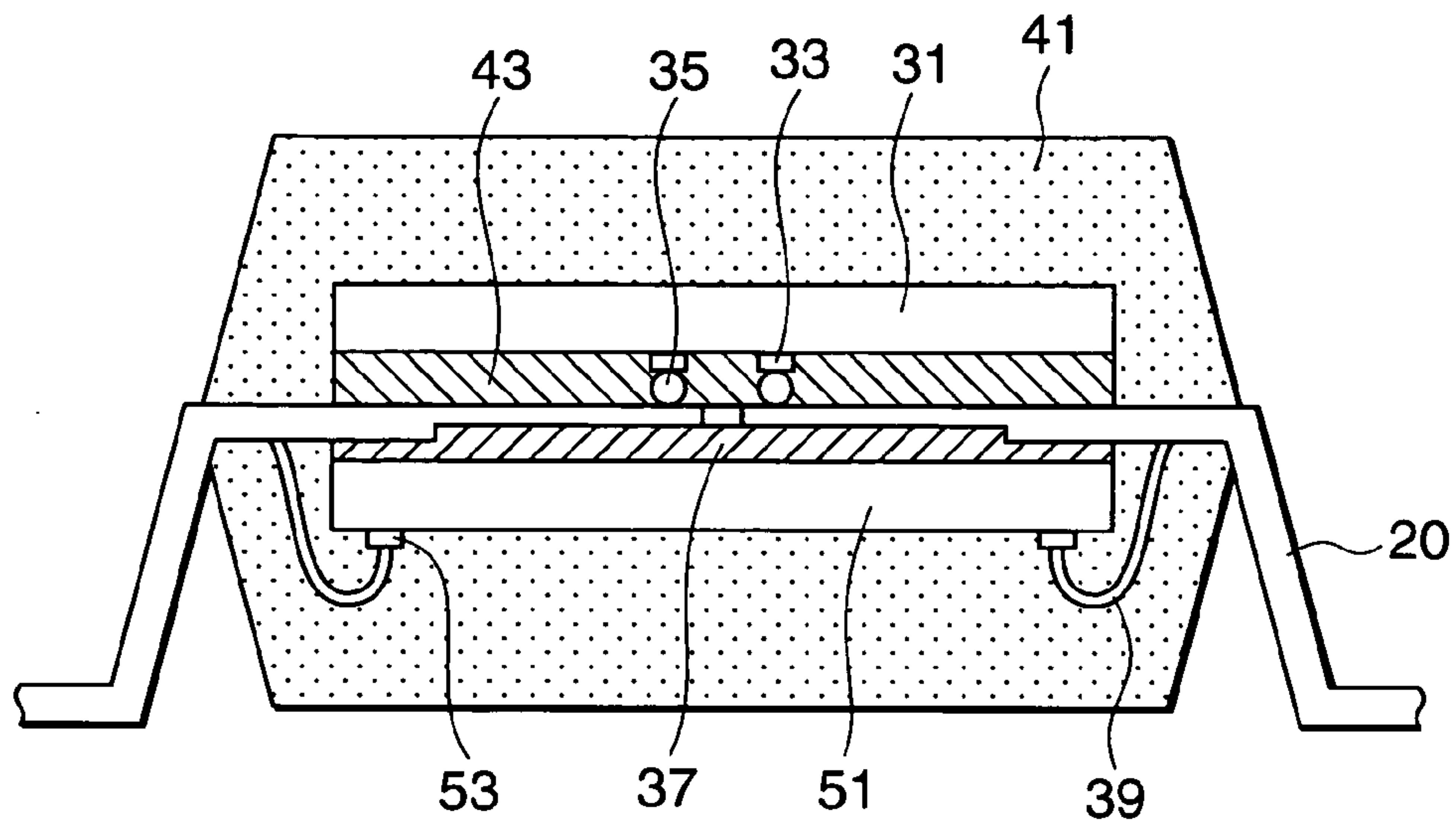
FIRST EMBODIMENTS OF SEMICONDUCTOR DEVICE AND LEAD FRAME

FIG.7



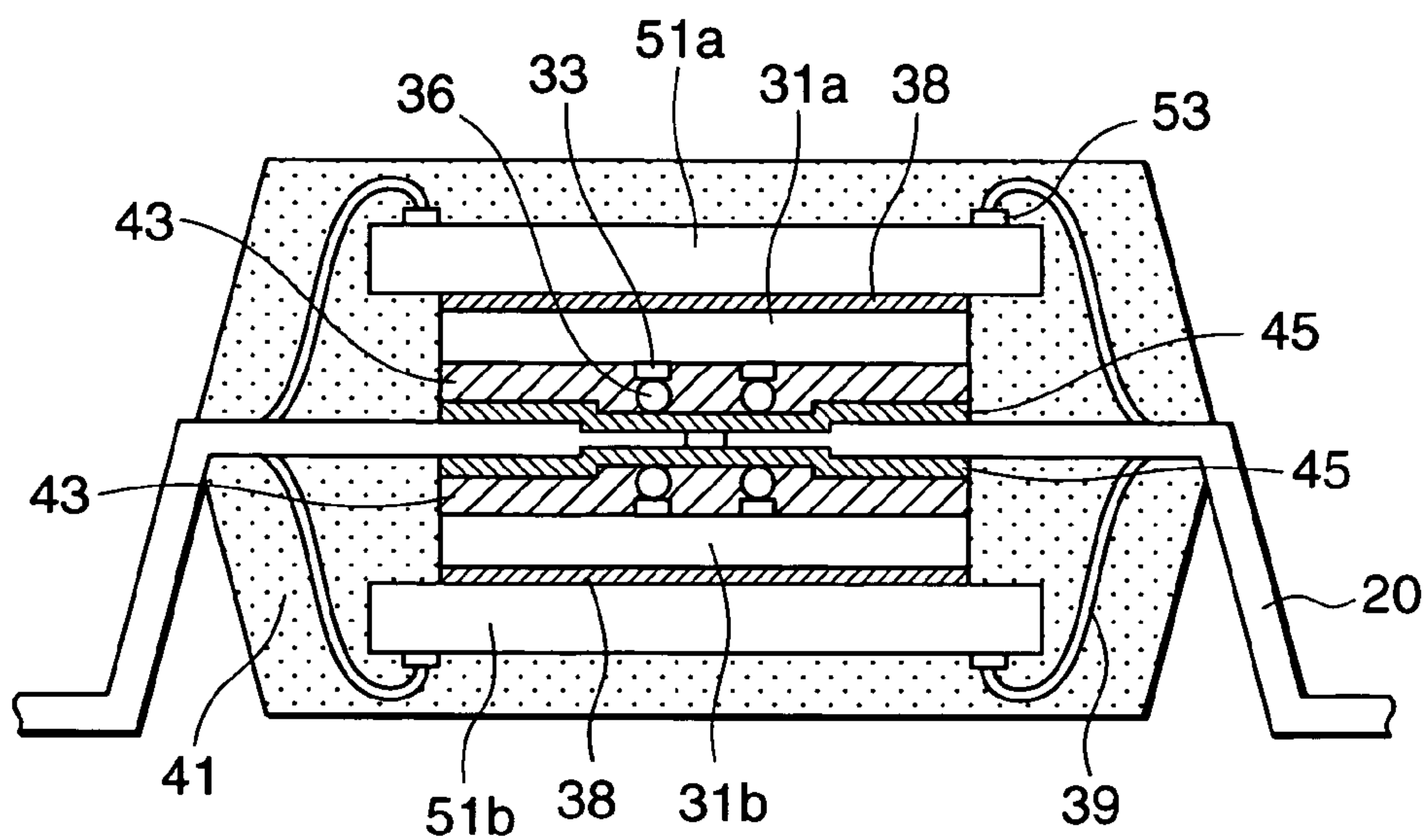
THIRD EMBODIMENT OF LEAD FRAME

FIG.8



SECOND EMBODIMENT OF SEMICONDUCTOR DEVICE

FIG.9



THIRD EMBODIMENT OF SEMICONDUCTOR DEVICE

FIG.10A

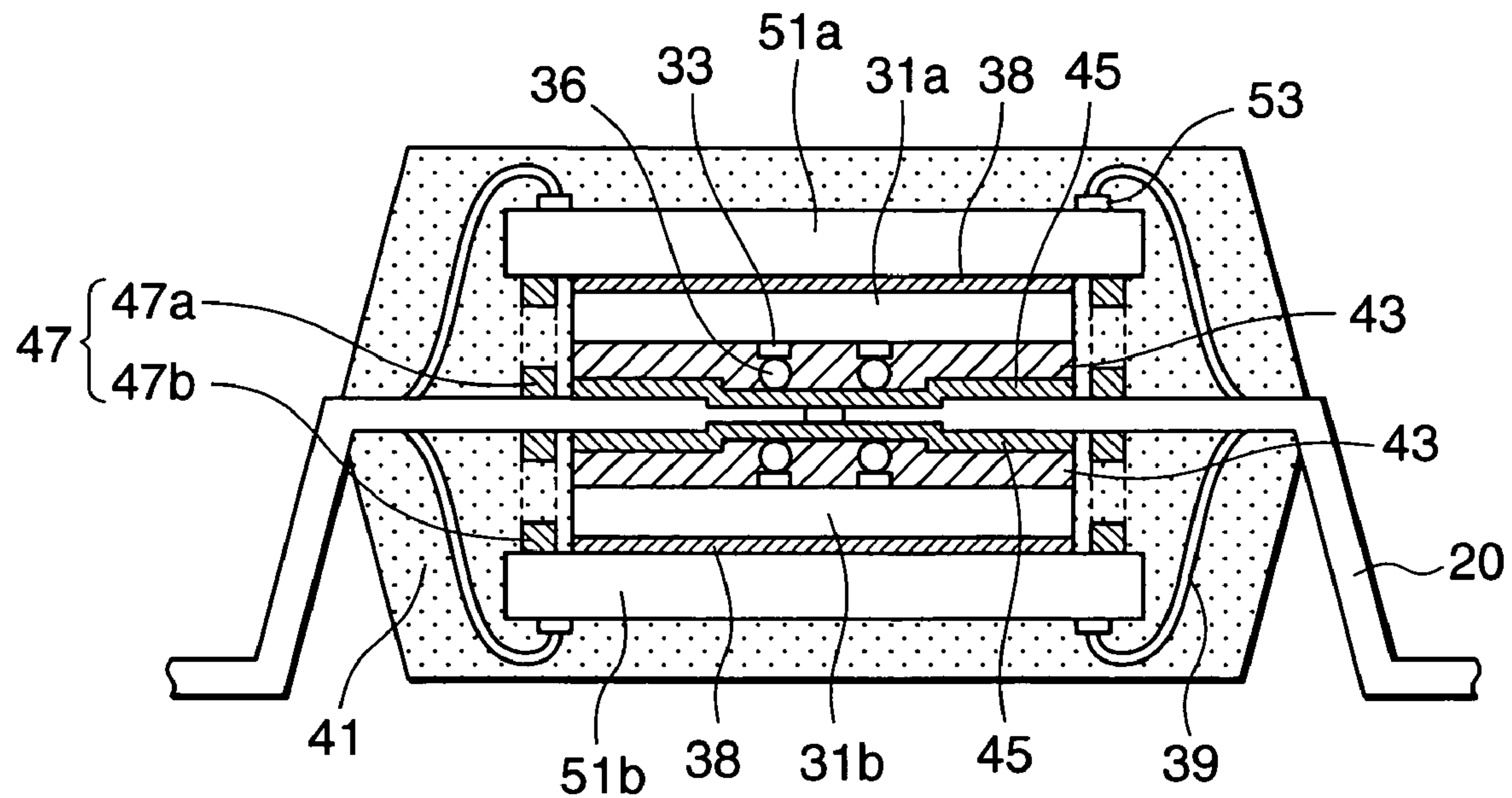
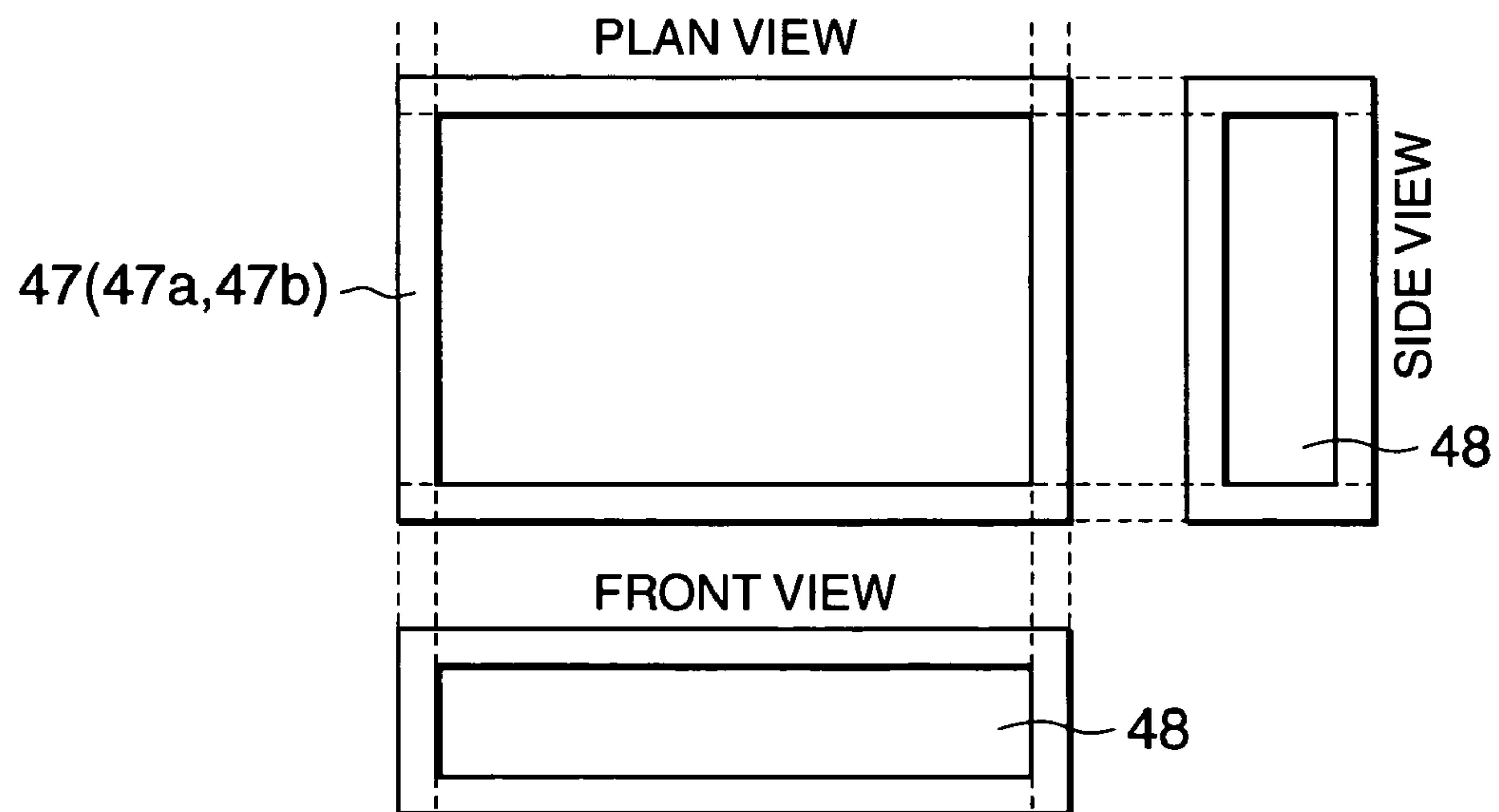
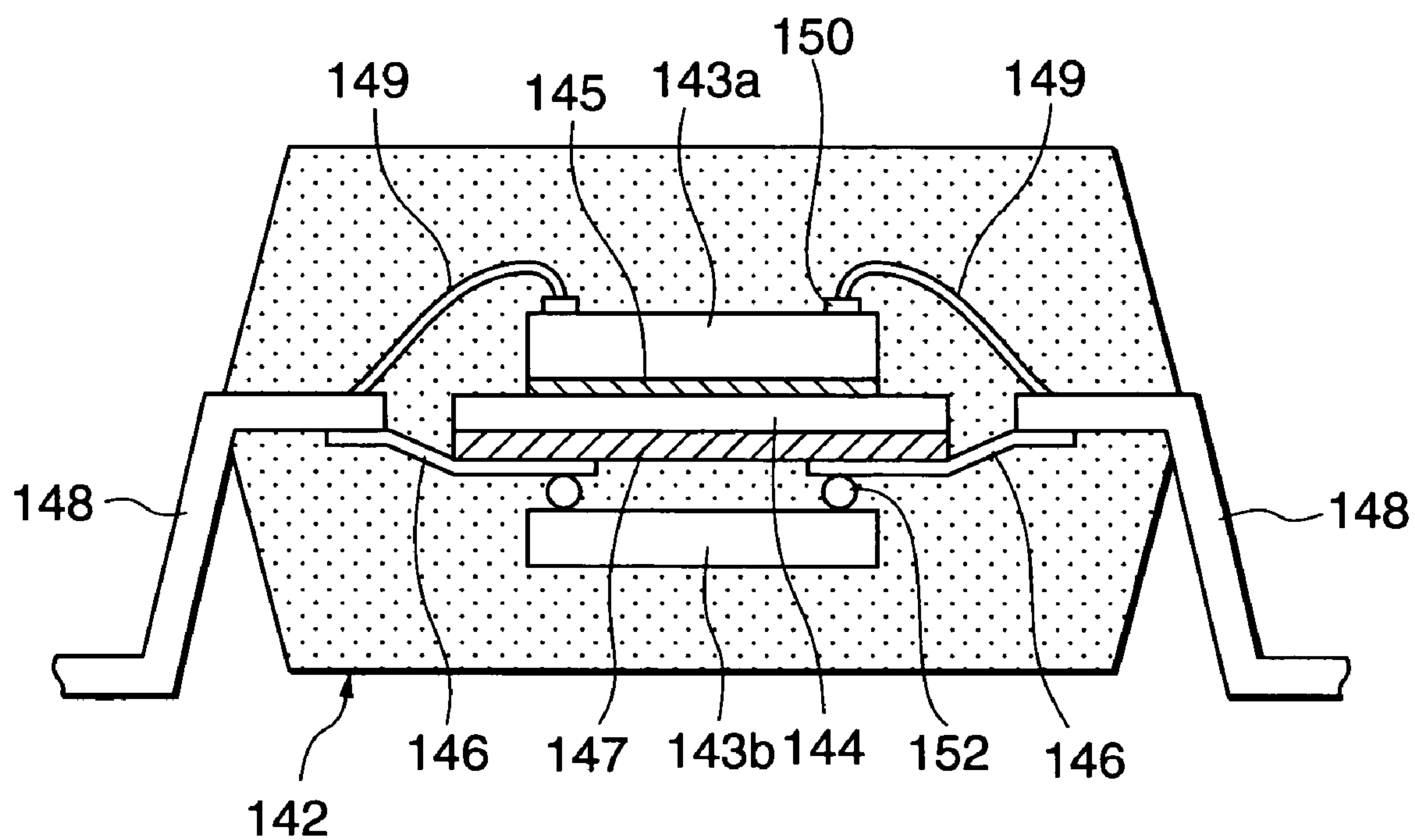


FIG.10B



FOURTH EMBODIMENT OF SEMICONDUCTOR DEVICE

FIG. 11



CONVENTIONAL EXAMPLE OF SEMICONDUCTOR DEVICE

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LEAD FRAME, MANUFACTURING METHOD OF THE SAME, AND SEMICONDUCTOR DEVICE USING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a lead frame, a manufacturing method of the lead frame, and a semiconductor device that is packaged by using the lead frame.

2. Description of the Related Art

The development of a technology of a semiconductor integrated circuit has heightened a request for high-density mounting especially by using multiple pins. In response to such a request, various packaging forms have been developed for semiconductor devices.

There is a resin sealed package of a lead frame type as one of the packaging forms of the semiconductor devices. The resin sealed package has been widely used because of an inexpensive material and a shape that is suited to mass production.

In the package of the lead frame type, a semiconductor element and an inner lead portion of the lead frame are generally connected to each other through a metal wire (e.g., see Patent Document 1 as identified below).

A constitutional example of a conventional semiconductor device sealed by a resin sealed package **142** of a lead frame type will now be described with reference to FIG. **11**. Two semiconductor elements **143a** and **143b** are mounted in the resin sealed package **142**. One semiconductor element **143a** is stuck to an upper surface of a dye stage **144** by a semiconductor element adhesive **145**. An upper surface of the semiconductor element **143a** is a circuit formation surface, and one end of a metal wire **149** is attached to a bonding electrode **150** on the circuit formation surface. Further, the other end of the metal wire **149** is connected to an inner lead portion of a lead frame **148**.

An upper surface of the other semiconductor element **143b** is a circuit formation surface, and one end of a tab lead **146** is attached to a bump **152** on the circuit formation surface. Further, the other end of the tab lead **146** is connected to the inner lead portion of the lead frame **148**. The semiconductor element **143b** to which the tab lead **146** is attached is disposed below the dye stage **144** through an insulating material **147**.

If a metal wire is used for a connection between a semiconductor element and an inner lead portion of a lead frame, there is a possibility that wire cutting or the like will occur due to vibration or the like during package manufacturing. However, if a semiconductor chip and the inner lead portion are connected by flip chip bonding, the metal wire and a tab lead are made unnecessary. Thus, a possibility of metal wire cutting or the like can be eliminated, and the number of components can be reduced.

Patent Document 1: Japanese Patent Application Laid-Open No. 7 (1995)-30051 (claim 1 and FIG. 1)

SUMMARY OF THE INVENTION

However, the bonding electrodes on the semiconductor element are normally arranged at a pitch of about 80 to 200 μm , while an arrangement pitch of the inner lead portions of the lead frame is usually 180 μm or higher. Because of this difference in arrangement pitches, a semiconductor element which has bonding electrodes of an arrangement pitch of 180 μm or lower cannot be mounted by flip chip bonding.

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Such a limit of the arrangement pitch of the inner lead portions is defined by a lead frame thickness, and the lead frame thickness is in turn dependent on a processing limit of etching or mold processing.

The present invention has been made with the foregoing problems in mind. Accordingly, objects of the present invention are to provide a lead frame which enables mounting of a semiconductor element that is conventionally unmountable through flip chip bonding by reducing a pitch of inner lead portions of a lead frame, a manufacturing method of the lead frame, and a semiconductor device which uses the lead frame.

In order to achieve the foregoing objects of the present invention, a lead frame of the present invention has the following constitution. The lead frame comprises a plurality of leads that are arranged in parallel. Each of the plurality of leads is constituted by being divided into two portions of an inner lead portion and an outer lead portion. The inner lead portion has a fine inner lead portion, and a middle inner lead portion for interconnecting the fine inner lead portion and the outer lead portion. Each of the middle inner lead portion and the outer lead portion has a second thickness and a second width. The fine inner lead portion has a first thickness. The fine inner lead portion has a tip and a rear stage. The tip has a first width, and the rear stage has a width that is expanded from the first width of the tip to the second width of the middle inner lead portion. Further, the first thickness is smaller than the second thickness, and the first width is smaller than the second width.

A method for manufacturing the lead frame includes the following four steps. In a first step, a conductor plate is prepared. In a second step, a fine inner lead formation scheduled area is set in a center region of the conductor plate, and the fine inner lead formation scheduled area is half-etched to make a plate thickness smaller than that in a peripheral area of a nonetching target. In a third step, a first patterning process is executed in the fine inner lead formation scheduled area to form a fine inner lead portion. In a fourth step, a second patterning process is executed in the peripheral area to form a middle inner lead portion and an outer lead portion. In this case, the third and fourth steps are carried out after the second step, and the first and second patterning processes are carried out as different patterning processes.

In implementing the aforementioned manufacturing method, the second patterning process for forming the middle inner lead portion and the outer lead portion may preferably be executed by mold-processing the peripheral area.

An execution order of the third and fourth steps may be changed in accordance with a design.

A semiconductor device of the present invention is constituted by including the aforementioned lead frame and first and second semiconductor elements. An electrode of the first semiconductor element is connected through flip chip bonding to the fine inner lead portion of the lead frame by a bump formed on the electrode. The second semiconductor element is stuck to a surface opposite a surface of the lead frame on which the first semiconductor element is mounted by a semiconductor element adhesive. One end of a wire is attached to an electrode disposed on a surface which is opposite the surface of the second semiconductor element stuck to the lead frame. The other end of the wire is attached to the middle inner lead portion of the lead frame. Resin sealing is executed to include (seal) the inner lead portion of

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the lead frame and the first and second semiconductor elements. The outer lead portion of the lead frame is exposed from a resin-sealed portion.

According to a preferred embodiment of the lead frame of the invention, in addition to the original leads, the lead frame comprises a plurality of spare leads each of which is constituted by being divided into two portions of a spare inner lead portion and a spare outer lead portion. The spare leads are arranged in parallel to be apart from the leads in areas between the middle inner lead portions of the adjacent leads. Further, the spare leads are arranged from a boundary between the middle inner lead portion and the fine inner lead portion of the lead to the area of the outer lead portion side.

According to another embodiment of a semiconductor device of the present invention, the semiconductor device is constituted by including an inner lead portion of a lead frame and two pairs of first and second semiconductor elements. The two first semiconductor elements are connected through an anisotropic conductive sheet to front and back sides of the fine inner lead portion of the lead frame by electrodes disposed on the first semiconductor elements and bumps formed on the electrodes. The two second semiconductor elements are stuck to surfaces which are opposite surfaces of the first semiconductor elements stuck to the lead frame by a semiconductor element adhesive. One end of a wire is attached to an electrode disposed on a surface opposite the surface of each of the second semiconductor elements stuck to each of the first semiconductor elements. The other end of the wire is attached to the middle inner lead portion of the lead frame. Resin sealing is executed to include (seal) the inner lead portion of the lead frame and the two pairs of first and second semiconductor elements. The outer lead portion of the lead frame is exposed from a resin-sealed portion.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A and 1B are views illustrating a manufacturing process (first step) of a lead frame, where FIG. 1A is a schematic plan view, and FIG. 1B is a sectional view cut along the line A—A of FIG. 1A;

FIGS. 2A and 2B are views illustrating the manufacturing process (second step) of the lead frame, where FIG. 2A is a schematic plan view, and FIG. 2B is a sectional view cut along the line A—A of FIG. 2A;

FIGS. 3A and 3B are views illustrating the manufacturing process (third step) of the lead frame, where FIG. 3A is a schematic plan view, and FIG. 3B is a sectional view cut along the line A—A of FIG. 3A;

FIGS. 4A and 4B are views illustrating the manufacturing process (fourth step) of the lead frame, where FIG. 4A is a schematic plan view, and FIG. 4B is a sectional view cut along the line A—A of FIG. 4A;

FIGS. 5A and 5B are views illustrating a semiconductor device and a lead frame used for the semiconductor device, where FIG. 5A is a schematic sectional view illustrating a first embodiment of the semiconductor device, and FIG. 5B is a schematic plan view illustrating a first embodiment of the lead frame;

FIG. 6 is a schematic plan view illustrating a second embodiment of a lead frame of the present invention;

FIG. 7 is a schematic plan view illustrating a third embodiment of a lead frame of the present invention;

FIG. 8 is a schematic sectional view illustrating a constitution of a second embodiment of a semiconductor device of the present invention;

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FIG. 9 is a schematic sectional view illustrating a constitution of a third embodiment of a semiconductor device of the present invention;

FIGS. 10A and 10B are views illustrating a constitution of a fourth embodiment of a semiconductor device of the present invention, where FIG. 10A is a schematic sectional view showing the semiconductor device, and FIG. 10B illustrates plan, front and side views schematically showing a frame material used for the semiconductor device; and

FIG. 11 is a sectional view illustrating a semiconductor device of a conventional example.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The preferred embodiments of the present invention will now be described with reference to the accompanying drawings. However, constitutions and arrangement relations are only schematically shown so as not to hinder understanding of the present invention. Preferred constitutional examples of the present invention will be described. However, compositions (materials), numerical value conditions etc., of the constitutions are only preferred examples, and thus the present invention is not limited to the embodiments.

When a schematic view illustrating a constitutional example of a semiconductor device of the present invention is a sectional cut, hatching of the section is partially omitted.

(Method for Manufacturing Lead Frame)

A lead frame manufacturing method of the present invention will now be described with reference to FIGS. 1A to 4B. The description below will focus on one lead frame.

In a first step, a conductor plate 10 is prepared. A material of the conductor plate 10 is, e.g., copper. A plate thickness of the conductor plate 10 is set to, e.g., about 200 μm (see FIGS. 1A, 1B).

In a second step, a fine inner lead formation scheduled area 14 is set in a center region of the conductor plate 10. The fine inner lead formation scheduled area 14 is set as an area of an etching target, while a peripheral area 15 of the fine inner lead formation scheduled area 14 is set as an area of a nonetching target. Then, a resist pattern is formed which has an opening in the fine inner lead formation scheduled area 14 set as the etching target area, and covers the peripheral area 15 set as the nonetching target area. The fine inner lead formation scheduled area 14 is half-etched to set a plate thickness which is smaller than that of the peripheral area 15. The half-etching is preferably executed by chemical etching (see FIGS. 2A, 2B).

In this case, a plate thickness of the fine inner lead formation scheduled area 14 is about 100 μm , while a plate thickness of the peripheral area 15 is maintained at about 200 μm . In the constitutional example described here, a planar shape of the etching target area 14 is square. A size of the fine inner lead formation scheduled area 14 is decided by the arrangement of a bonding electrode disposed on a semiconductor element mounted on the lead frame.

In a third step, the thin fine inner lead formation scheduled area 14 is patterned by a first patterning process to form a fine inner lead portion 22 (see FIGS. 3A, 3B).

In this patterning, first, a resist pattern is disposed to cover an area of the fine inner lead formation scheduled area 14 for forming a fine inner lead portion and the peripheral area 15. Then, a portion of the fine inner lead formation scheduled area 14 that is exposed from the resist pattern is preferably subjected to chemical etching to be removed, thereby completing the patterning.

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Thus, if the resist pattern is disposed in the fine inner lead formation scheduled area **14** so as to coincide with a pitch of bonding electrodes of the semiconductor element, an arrangement pitch of fine inner lead portions **22** obtained after the etching removal is set to be equal to the arrangement pitch of the electrodes. Since the fine inner lead portion **22** can be formed narrow by making its thickness small, the arrangement pitch of the fine inner lead portions **22** can be reduced.

In a fourth step, the peripheral area **15** which is the nonetching target in the half-etching of the second step is patterned by a second patterning process to form a middle inner lead portion **23** and an outer lead portion **25** (see FIGS. 4A, 4B).

In this case, first, a resist pattern is disposed to cover the formed fine inner lead portion **22**, an area in which the middle inner lead portion **23** and the outer lead portion **25** are formed, as well as a support frame **19** which supports these lead frames, and to expose the remaining peripheral area **15**. Then, the exposed peripheral area **15** is preferably subjected to chemical etching to be removed. As a result, a lead frame **20** supported by the support frame **19** (also referred to as a frame) is formed.

If a material of the conductor plate **10** is copper, the half-etching of the second step and the patterning operations of the third and fourth steps are preferably carried out by chemical etching which uses iron chloride as an etching agent.

In the formation of the middle inner lead portion **23** and the outer lead portion **25** of the fourth step, since a lead frame pitch is permitted to be 180 μm or higher, these portions may be formed by mold processing of a conventional art as a second patterning process.

The mold processing is physical patterning. Thus, the patterning is easier than chemical patterning.

An execution order of the third and fourth steps may be changed in accordance with a design.

A lead frame of an arrangement pitch of about 180 μm has been conventionally manufactured. Thus, if a plate thickness of the fine inner lead formation scheduled area **14** is set to be about half of that of the peripheral area **15** of the nonetching target, an arrangement pitch of fine inner lead portions can be realized up to approximately 80 μm . In this case, a semiconductor element in which an arrangement pitch of bonding electrodes is about 80 μm can be mounted through flip chip bonding.

After the formation of the lead frame **20** that is supported by the support frame **19**, components such as the semiconductor elements which are necessary for packaging are mounted on the inner lead portion **21** which comprises the fine inner lead portion **22** and the middle inner lead portion **23**. Then, molding is carried out to include the inner lead portion **21** and the elements, i.e., resin sealing is carried out, and then the lead frame **20** is cut off from the support frame **19** to complete a resin sealed package.

(Lead Frame)

First Embodiment

A structure of the lead frame manufactured by the foregoing method will be described by referring to FIGS. 4B and 5B. This lead frame is used for a resin sealing (molding) package of a lead frame type which is one of the packaging forms of the semiconductor device.

The lead frame **20** comprises a plurality of leads **27** that are substantially arranged in parallel. Each of the leads **27** is constituted by being divided into two portions of an inner

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lead portion **21** and an outer lead portion **25**. A portion of the lead frame **20** included in the package is the inner lead portion **21**, and a portion exposed to the outside of the package is the outer lead portion **25**.

The inner lead portion **21** has a fine inner lead portion **22**, and a middle inner lead portion **23** for interconnecting the fine inner lead portion **22** and the outer lead portion **25**. The fine inner lead portion **22** is freely conducted to an external opponent of a connection through the middle inner lead portion **23** and the outer lead portion **25**.

Each of the middle inner lead portion **23** and the outer lead portion **25** has a second thickness t_2 and a second width w_2 .

The fine inner lead portion **22** has a first thickness t_1 . The first thickness t_1 is smaller than the second thickness t_2 . The fine inner lead portion **22** has a tip **22a**, and a rear stage **22b** continuous from the tip. The tip **22a** of the fine inner lead portion **22** has a first width w_1 . The first width w_1 is smaller than the second width w_2 . The rear stage **22b** of the fine inner lead portion **22** is preferably expanded in width from the first width w_1 of the tip to the second width w_2 of the middle inner lead portion. In FIG. 5B, a boundary between the tip **22a** and the rear stage **22b** of the fine inner lead portion is denoted by L1, a boundary between the fine inner lead portion **22** and the middle inner lead portion **23** is denoted by L2, and a boundary between the middle inner lead portion **23** and the outer lead portion **25** is denoted by L3.

When the plurality of leads **27** are arranged in parallel, an arrangement pitch of the inner lead portions **21** is normally about twice as large as a width of each inner lead portion **21**. It is now assumed that an arrangement pitch of the tips **22a** of the finer inner lead portions **22** is a first pitch d_1 , and an arrangement pitch of the middle inner lead portions **23** is a second pitch d_2 . In this case, the second pitch d_2 is approximately 180 μm or higher, while the first pitch d_1 is about 80 μm . As an electrode pitch of a generally used semiconductor element is approximately 80 to 200 μm , in the aforementioned example, the first pitch d_1 of the tip **22a** of the fine inner lead portion **22** is about 80 μm , but this first pitch d_1 can be set to 80 μm or lower by making the first width w_1 smaller in accordance with a thickness of the tip **22a**.

The embodiment has been described by way of example in which the rear stage **22b** of the fine inner lead portion **22** has a width that is tapered from the middle inner lead portion **23** side to the tip **22a**. However, the width of the rear stage **22b** may be set to a constant width which is equal to that of the tip **22a**.

Second Embodiment

A structure of a lead frame **20a** of a second embodiment will be described by referring to FIG. 6. A constitutional difference of the lead frame of the second embodiment from that of the first embodiment is a structure in which a spare lead **28a** is additionally disposed.

The spare leads **28a** are arranged in parallel to be apart from the original leads **27** in areas between the middle inner lead portions **23** of the adjacent original leads **27** arranged in parallel. Each of the spare leads **28a** is positioned for its front stage edge in any position in an area of the outer lead portion **25** side from a boundary between the middle inner lead portion **23** and the fine inner lead portion **22** of the original lead **27** to be extended to the outer lead portion side.

Each spare lead **28a** is constituted by being divided into two portions of a spare inner lead portion **24a** and a spare

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outer lead portion **26a**. Thus, in the spare lead **28a**, a portion corresponding to the fine inner lead portion **22** of the original lead **27** is not formed.

As shown in FIG. 6, a maximum occupied area **52a** when a second semiconductor element **51** is mounted on the lead frame is indicated by a dotted line. The spare lead **28a** is formed in a package so that a spare inner lead portion **24a** can be arranged in an area outside the occupied area **52a**. The spare lead **28a** may be formed simultaneously with the formation of the original lead **27**. A necessary number of spare leads **28a** may be disposed between the two original leads **27** as the occasion demands.

According to the lead frame constitution which comprises the spare leads, a bonding electrode of the second semiconductor element can be connected to the lead which is different from the lead connected through flip chip bonding to the bonding electrode of the first semiconductor element. Moreover, even if the first and second semiconductor elements are different from each other in the number of bonding electrodes, or arrangement thereof, they can be mounted on one lead frame.

Third Embodiment

Next, a structure of a lead frame **20b** of a third embodiment will be described by referring to FIG. 7. A constitutional difference of the lead frame **20b** of the third embodiment from that of the second embodiment is the constitution itself of a spare lead **28b**.

In the lead frame **20b** of the third embodiment, as apparent from a comparison of the constitutional examples of FIGS. 6 and 7, a spare inner lead portion **24b** is formed longer than that in the case of the second embodiment, and extended so as not to reach a boundary **L2** to the inside of an occupied area **52b** of a second semiconductor element **51**. Accordingly, in this case, a tip of the spare inner lead portion **24b** is fixed to a front surface side of the second semiconductor element by a semiconductor element adhesive on the second semiconductor element **51**. Since the spare inner lead portion **24b** is fixed to the second semiconductor element **51**, it is possible to prevent deformation of the spare inner lead portion **24b** during assembly of a semiconductor device.

(Semiconductor Device)

First Embodiment

A constitution of a semiconductor device which uses the foregoing lead frame will be described by referring to FIGS. 5A and 5B.

A first semiconductor element **31** is mounted on a lead frame **20**. One surface of the first semiconductor element **31** is a circuit formation surface, and a bonding electrode **33** is disposed thereon as an electrode. A solder bump **35** is formed as a bump on the bonding electrode **33**. By this solder bump **35**, the bonding electrode **33** of the first semiconductor element **31** is connected through flip chip bonding to, especially, a tip **22a** of a fine inner lead portion **22** of the lead frame **20**.

A second semiconductor element **51** is stuck to a surface opposite a surface of the lead frame **20** on which the first semiconductor element **31** is mounted by a semiconductor element adhesive **37**. This semiconductor element adhesive is an insulating adhesive which contains an epoxy resin.

A surface opposite a surface of the second semiconductor element **51** stuck to the lead frame **20** is a circuit formation surface. One end of a metal wire **39** is attached as a bonding wire through solder bonding or the like to a bonding

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electrode **53** on the circuit formation section. The other end of the metal wire **39** is attached through solder bonding or the like to a middle inner lead portion **23** of the lead frame **20**.

Resin sealing is carried out to cover an inner lead portion **21** of the lead frame **20** and the first and second semiconductor elements **31** and **51**. An outer lead portion **25** of the lead frame **20** is exposed from a resin sealed package **41**.

If the bonding electrodes **33** and **53** of the first and second semiconductor elements **31** and **51** are similarly arranged, and an arrangement pitch of the bonding electrodes **33** and **53** coincides with that of the tips **22a** of the fine inner lead portions **22** of the lead frame **20**, the second semiconductor element **51** can be mounted through flip chip bonding as in the case of the first semiconductor element **31**.

Second Embodiment

A constitution of a second embodiment of a semiconductor device of the present invention will be described by referring to FIG. 8. A difference from the first embodiment is that an insulating resin, e.g., an epoxy resin **43**, fills a space between an inner lead portion **21** of a lead frame **20** and a first semiconductor element **31**.

A reason for the disposition of the insulating resin layer of the epoxy resin **43** or the like is as follows. When a mold resin is disposed to envelope the semiconductor element, a bonding metal wire or the like mounted on the lead frame **20**, the mold resin enters the space between the inner lead portion **21** of the lead frame **20** and the first semiconductor element **31**. Application of pressure at the time of the resin entry may expand a gap between the first semiconductor element **31** and the inner lead portion **21**. Consequently, there is a possibility of the generation of cracks in a solder bump.

However, according to the second embodiment, before molding, the space between the first semiconductor element **31** and the inner lead portion **21** is filled with the epoxy resin **43** to form a resin layer beforehand. By this epoxy resin **43**, entry of the mold resin to the space between the semiconductor element **31** and the inner lead portion **21** during molding is prevented. Thus, there is no possibility of the generation of cracks in the solder bump **35**, and therefore a highly reliable semiconductor device can be provided.

Third Embodiment

A constitution of a third embodiment of a semiconductor device of the present invention will be described by referring to FIG. 9.

According to the third embodiment, two first semiconductor elements **31a** and **31b** are mounted on a lead frame **20** in a state in which bonding electrodes face each other. One surface of each of the two first semiconductor elements **31a** and **31b** is a circuit formation surface, and a bonding electrode **33** is disposed thereon as an electrode. An Au bump **36** is formed as a bump on the bonding electrode **33**. By the Au bump **36**, the bonding electrode **33** is connected through an anisotropic conductive sheet **45** to front and back sides of a fine inner lead portion **22** of the lead frame **20**. A tip **22a** of the fine inner lead portion **22** of the lead frame **20** is etched to equal depths from both sides of a conductor plate to be removed, thereby being formed as a thin portion in a center of the conductor plate.

In this case, the anisotropic conductive sheet **45** has a structure which includes an area of a conductor in an insulating sheet. Normally, an insulating state is set between

two optional points of the anisotropic conductive sheet **45**. By heating and pressing during bonding, the area of the conductor in the heated and pressed anisotropic conductive sheet **45** is connected. As described above, the anisotropic conductive sheet **45** is a sheet which can set a conductive state between front and back sides of a predetermined place, and insulating states in other portions.

As in the case of the foregoing second embodiment of the semiconductor device, according to the third embodiment, a space between each of the first semiconductor elements **31a** and **31b** and the inner lead portion **21** of the lead frame **20** is filled with an epoxy resin **43**.

Two second semiconductor elements **51a** and **51b** are stuck to surfaces that are opposite the surfaces of the first semiconductor elements **31a** and **31b** which are connected to the lead frame **20** by semiconductor element adhesives **38**.

One end of a metal wire **39** is attached to a bonding electrode **53** disposed on a surface opposite each of the surfaces of the second semiconductor elements **51a** and **51b** that are stuck to the first semiconductor elements **31a** and **31b**. The other end of the metal wire **39** is attached to a middle inner lead portion **23** of the lead frame **20**. The connection of the metal wire **39** to the bonding electrode **53** and the middle inner lead portion **23** is carried out through solder bonding or the like.

Resin sealing (molding) **41** is carried out to cover the inner lead portion **21** of the lead frame **20** and the two pairs of the first and second semiconductor elements **31a**, **31b**, and **51a**, **51b**. An outer lead portion **25** of the lead frame **20** is exposed to the outside from the mold portion **41**.

According to the third embodiment, since a pair of first semiconductor elements and a pair of second semiconductor elements are mounted on the front and back sides of the lead frame, one semiconductor device can exhibit characteristic of two, and high-density mounting is possible.

Fourth Embodiment

A constitution of a fourth embodiment of a semiconductor device of the present invention will be described by referring to FIGS. **10A** and **10B**. According to the fourth embodiment, use of a frame material **47** to fix second semiconductor elements **51a** and **51b** is different from the semiconductor device of the third embodiment. Here, a structure of the frame material **47** of the fourth embodiment will be mainly described.

The frame material **47** has a sectional shape of surrounding a first semiconductor element which is similar to that obtained by cutting a rectangular portion which is equal in size and shape to the first semiconductor element out of a rectangle which is equal in size and shape to a second semiconductor element. Two frame materials **47** are disposed: one frame material **47a** being used for fixing one second semiconductor element **51a**, and the other frame material **47b** being used for fixing the other second semiconductor element **51b**. A height of the frame material **47** is approximately equal to a distance from the middle inner lead portion **23** of the lead frame **20** to each of the second semiconductor elements **51a** and **51b**.

The frame materials **47a** and **47b** are attached by epoxy resins or the like (not shown) to the middle inner lead portion **23** to individually surround the first semiconductor elements **31a** and **31b**. Further, the second semiconductor elements **51a** and **51b** are similarly fixed to the frame materials **47a** and **47b** by epoxy resins or the like (not shown).

An opening or a slit **48** is bored on each side face of the frame material **47** to inject a mold resin.

Since the second semiconductor elements **51a** and **51b** are fixed by the frame materials **47**, when the second semiconductor elements **51a** and **51b** are connected by the metal wire **39**, vibration thereof is suppressed, and vibration of the inner lead portion of the lead frame is also suppressed. Thus, a possibility of wire cutting or the like is reduced, and a highly reliable semiconductor device can be provided.

According to the lead frame of the present invention, since the tip of the inner lead portion of the lead frame is smaller in width than the middle inner lead portion, the arrangement pitch of the tips of the inner lead portions is small, and the semiconductor element can be mounted even through flip chip bonding.

According to the lead frame manufacturing method of the present invention, the fine inner lead formation scheduled area is half-etched to set the plate thickness smaller than that in the peripheral area of a nonetching target, and then, the fine inner lead formation scheduled area and the peripheral area are subjected to different patterning processes. Thus, the tip of the fine inner lead portion of the inner lead portion can be formed narrower than that of the conventional inner lead portion. It is therefore possible to reduce the arrangement pitch of the fine inner lead portions.

According to the lead frame manufacturing method of the invention, if the second patterning process is mold processing, the patterning becomes easier than chemical patterning because the mold processing is physical patterning.

According to the semiconductor device of the present invention, since the fine inner lead portion of the lead frame is narrower than that of the conventional lead frame, the arrangement pitch of the fine inner lead portions can be set smaller than that of the conventional lead frame. Thus, the number of components such as a wire can be reduced by flip chip bonding. Moreover, since no wire is used to mount the first semiconductor element, there is no fear that a phenomenon of wire cutting which has conventionally been possible due to vibration or the like during the semiconductor assembly will occur.

According to the lead frame of the present invention comprising the plurality of spare leads each of which is divided into the two portions of the spare inner lead portion and the spare outer lead portion, the electrode of the second semiconductor element can be connected to the lead that is different from the lead connected to the electrode of the first semiconductor element through flip chip bonding. Even if the first and second semiconductor elements are different from each other in the number of electrodes or electrode arrangement, they can be mounted on one lead frame.

The two first semiconductor elements are mounted on the front and back sides of the fine inner lead portion of the lead frame through the anisotropic conductive sheet. Further, the two second semiconductor elements are mounted on the surface that is opposite the surface connected to the lead frame by the semiconductor element adhesive. Thus, one semiconductor device can exhibit characteristics of two devices.

What is claimed is:

1. A lead frame comprising:

a plurality of leads arranged in parallel, wherein each of said leads is constituted by being divided into two portions of an inner lead portion and an outer lead portion, said inner lead portion has a fine inner lead portion and a middle inner lead portion for interconnecting said fine inner lead portion and said outer lead portion,

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said fine inner lead portion has a first thickness,
 each of said middle inner lead portion and said outer
 lead portion has a second thickness and a second
 width,
 said fine inner lead portion has a tip of a first width, and 5
 a rear stage expanded in width from the first width of
 said tip to the second width of said middle inner lead
 portion,
 the first thickness is smaller than the second thickness,
 and 10
 the first width is smaller than the second width; and
 a plurality of spare leads each of which is constituted by
 being divided into two portions of a spare inner lead
 portion and a spare outer lead portion, wherein
 said spare leads are arranged in parallel to be apart from 15
 said leads in areas between said middle inner lead
 portions of the adjacent leads, and
 said spare leads are respectively arranged from a
 boundary between said middle inner lead portion and
 said fine inner lead portion of the adjacent lead to the 20
 area of said outer lead portion side.

2. A semiconductor device comprising:

a lead frame;
 a first semiconductor element; and
 a second semiconductor element, wherein: 25
 said lead frame comprises a plurality of leads arranged in
 parallel;
 each of said leads is constituted by being divided into two
 portions of an inner lead portion and an outer lead
 portion; 30
 said inner lead portion has a fine inner lead portion and a
 middle inner lead portion for interconnecting said fine
 inner lead portion and said outer lead portion;
 said fine inner lead portion has a first thickness;
 each of said middle inner lead portion and said outer lead 35
 portion has a second thickness and a second width;
 said fine inner lead portion has a tip of a first width, and
 a rear stage expanded in width from the first width of
 said tip to the second width of said middle inner lead
 portion; 40
 the first thickness is smaller than the second thickness,
 and the first width is smaller than the second width;
 an electrode of said first semiconductor element is con-
 nected through flip chip bonding to a respective one of 45
 said fine inner lead portions of said lead frame by a
 bump formed on the electrode;
 said second semiconductor element is stuck to a surface
 opposite a surface of said lead frame on which said first
 semiconductor element is mounted by a semiconductor 50
 element adhesive;
 one end of a wire is attached to an electrode disposed on
 a surface opposite the surface of said second semicon-
 ductor element stuck to said lead frame;
 the other end of the wire is attached to a respective one of 55
 said middle inner lead portions of said lead frame;
 resin sealing is executed to include said inner lead por-
 tions of said lead frame and said first and second
 semiconductor elements; and
 said outer lead portions of said lead frame are exposed 60
 from a resin-sealed portion.

3. A semiconductor device comprising:

a lead frame;
 two first semiconductor elements; and
 two second semiconductor elements, wherein: 65
 said lead frame comprises a plurality of leads arranged in
 parallel;

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each of said leads is constituted by being divided into two
 portions of an inner lead portion and an outer lead
 portion;
 said inner lead portion has a fine inner lead portion and a
 middle inner lead portion for interconnecting said fine
 inner lead portion and said outer lead portion;
 said fine inner lead portion has a first thickness;
 each of said middle inner lead portion and said outer lead
 portion has a second thickness and a second width;
 said fine inner lead portion has a tip of a first width, and
 a rear stage expanded in width from the first width of
 said tip to the second width of said middle inner lead
 portion;
 the first thickness is smaller than the second thickness,
 and the first width is smaller than the second width;
 said two first semiconductor elements are connected
 through an anisotropic conductive sheet to front and
 back sides of said fine inner lead portions of said lead
 frame by electrodes disposed on said first semiconduc-
 tor elements and bumps formed on the electrodes;
 a space between said first semiconductor elements and
 said inner lead portions of said lead frame is filled with
 an epoxy resin;
 said two second semiconductor elements are stuck to
 surfaces opposite surfaces of said first semiconductor
 elements stuck to said lead frame by a semiconductor
 element adhesive;
 one end of a wire is attached to an electrode disposed on
 a surface opposite the surface of each of said second
 semiconductor elements stuck to each of said first
 semiconductor elements;
 the other end of the wire is attached to a respective one of
 said middle inner lead portions of said lead frame;
 resin sealing is executed to include said inner lead por-
 tions of said lead frame and said two pairs of first and
 second semiconductor elements; and
 said outer lead portions of said lead frame are exposed
 from a resin-sealed portion.

4. A semiconductor device comprising:

a lead frame having a plurality of arranged single-piece
 leads which each have an outer lead portion, a first
 inner lead portion and a second inner lead portion
 which is located between said first inner lead portion
 and said outer lead portion, said first inner lead portion
 having a first thickness and a first width, and said
 second inner lead portion having a second thickness
 which is larger than the first thickness and a second
 width which is larger than the first width;
 a first semiconductor element mounted on said lead
 frame, said first semiconductor element having a sur-
 face and a plurality of first electrodes provided on said
 surface of said first semiconductor element, and each of
 said plurality of first electrodes of said first semicon-
 ductor element being respectively connected to said
 first inner lead portions of said plurality of single-piece
 leads by a bump;
 a second semiconductor element mounted on said lead
 frame, said second semiconductor element having a
 surface and a plurality of second electrodes provided on
 said surface of said second semiconductor element, and
 each of said second electrodes of said second semicon-
 ductor element being respectively connected to said
 second inner lead portions of said plurality of single-
 piece leads by a wire.

5. A semiconductor device according to the claim 4,
 wherein said lead frame has a first surface and a second
 surface which is opposite to the first surface, said first

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semiconductor element being mounted on said first surface of said lead frame, and said second semiconductor element being mounted on said second surface of said lead frame.

6. A semiconductor device according to the claim 4, wherein said second semiconductor element is formed on said first semiconductor element. 5

7. A semiconductor device according to the claim 4, further comprising a resin sealing for sealing said lead frame, said first semiconductor element and said second semiconductor element.

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8. A semiconductor device according to the claim 7, wherein said outer lead portion of each of said plurality of single-piece leads is exposed from said resin sealing.

9. A semiconductor device according to the claim 4, wherein a first pitch of said first inner lead portions is smaller than a second pitch of said second inner lead portions.

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